ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.12

Optical Communication Performance Over a 10 Gigabit Speed Ethernet Network with Opnet Software

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Abstract:
A present computing imposes heavy demands on the optical communication network. Gigabit Ethernet technology can provide the required bandwidth to meet these demands. However, it has also in volve the communication Impediment to progress from network media to TCP (Transfer control protocol) processing. In this paper, present an overview of Gigabit per second Ethernet technology and study the end-to-end Gigabit Ethernet communication bandwidth and retrieval time. Performances graphs are collected using NetPipein this clearly show the performance characteristics of TCP/IP over Gigabit Ethernet. These indicate the impact of a number of factors such as processor speeds, network adaptors, versions of the Linux Kernel or opnet software and device drivers, and TCP/IP (Internet protocol) tuning on the performance of Gigabit Ethernet between two Pentium II/350 PCs. Among the important conclusions are the marked superiority of the2.1.121 and later development kernels and 2.2.x production kernels of Linux or opnet software used and that the ability to increase the MTU (maximum transmission unit) further than the Ethernet standard of 1500 could significantly enhance the throughput reachable.

I. INTRODUCTION

The Metro Ethernet network (MEN) expands the advantages of Ethernet to cover areas wider than LAN. MENs running Ethernet Services as specified by the Metro Ethernet Forum (MEF) are known as Carrier Ethernet Networks (CENs). CENs can cover not only metro areas, but it can expand to cover global areas by connecting multiple MENs. Next-generation CENs are expected to support 100 GbE. With arising technologies for Ultra Long-haul (ULH) networks the bandwidth bottleneck of CENs is shifting to other areas like the transport layer protocol (such as the Transport Control Protocol or TCP) and the chip-to-chip channel capacity found at the network edge, which in general has an electrical backplane. Traditional TCP is well known to have difficulties reaching the full available bandwidth, due to its inefficient AIMD mechanisms under a high-delay-bandwidth-product environment. At the network edge, network equipment with electrical backplanes poses many problems including inductive-capacitive effects that limit its bandwidth. These are the two main issues addressed in this work. To resolve the transport layer issue, this work proposes a transport protocol that fully utilizes the available bandwidth while preserving TCP- friendliness and providing QoS support that is compatible with Ethernet Services. It can guarantee throughputs above the Committed Information Rate (CIR), which is specified in the Service Level Agreement (SLA). To resolve the physical layer limitations, a novel optical coupling technique is examined to encourage the use of optical backplanes for network-edge and core technology. The proposed technique consists of aligning the normal of the laser emission plane, waveguide plane and the normal of the photo detector active region plane with the purpose of reducing optical power loss caused by common methods of light manipulation. By addressing the shortcomings of both Traditional TCP and electrical backplane technology the overall throughput can be significantly increased.

- OPNET Simulator
- *Network Implementation:-*
- *MPSL technology*
- Simulation setup for high speed optical communication through 100BaseT Ethernet

OPNET Simulator:-
OPNET simulator is a tool to simulate the behavior and performance of any type of network. The main difference with other simulators lies in its power and versatility. This simulator makes possible working with OSI model, from layer 7 to the modification of the most essential physical parameters. The OPNET modeler is a sophisticated work-station based environment for the modeling and simulation of communication systems, protocols and networks. It has a hierarchical, object-based modeling structure. It also has a graphical interface which displays the characteristics of different individual parameters in comparison with the other parameters. This software is relatively easy to use; a prognosis of the network can be performed. But the time for simulation of big networks can be cumbersome. It has a drag-and-drop scheme for setting up networks. A network editor provides us with the workspace to work with. The network is subdivided into subnets. It consists of graphical representation of network topology. It also consists of global, node and link models. This tutorial is divided in four parts. The aim of the first part is to give a global vision of OPNET MODELER. The second part provides basic concepts about programming simulation environments. The third part goes through the implementation of advanced networks. The last part deals with one of the most useful utilities of the simulator for ISP companies: the prediction of the behavior of big networks in

order to validate its design.

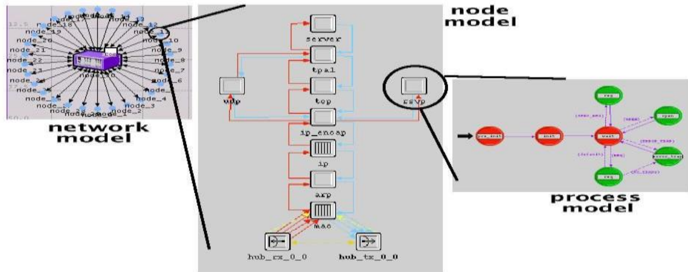
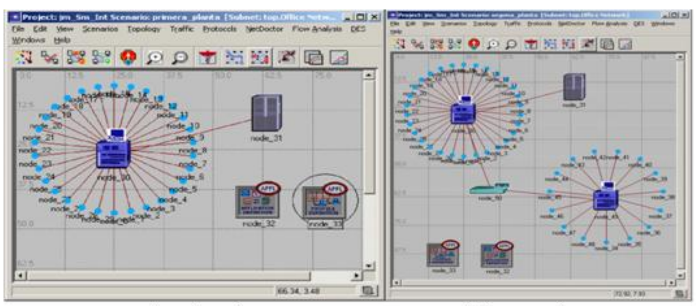


Figure.1. OPNET simulator

Network Implementation:-

The first scenario consists in the following: there is a company with a star topology network that wants to implement the same infrastructure in a second floor. Both networks are interconnected with a router. The purpose of this exercise is to check if the network will support it. The students should implement the initial topology and do the appropriate simulations. Then, they should proceed with the enlargement of the network, redo the simulations, compare the different obtained results and take some conclusions.

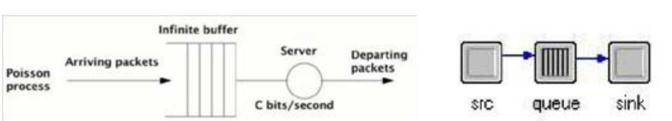


Current scenario *Future scenario*

Figure. 2. Network Implementation1

Low level design:-

In this exercise it is intended to give a wide knowledge about Node Editor. Students will create a node operating as a buffer, specifically as an infinite queue, where the first come is the first served (FIFO), also known as M/M/1 queue. Packets arriving to the buffer follow a Poisson distribution. The server function is to supply the packets in the buffer at a constant rate.



Theoretical design *Opnet design*

Figure.3. Low level design o f scenario

The processes are linked by flow data lines (blue line), one from the source to the queue, and one from the queue to the sink. When the node model implementation is finished, the students are asked to create a network model.

MPSL technology:-

First of all, a reference scenario will be created in order to observe some problems that can come up with routing protocols. Then, it will be configured the same scenario but introducing MPLS technology with Traffic Engineering, where two LSPs will be used to share out the traffic between the paths.

The last scenario will introduce the necessary configuration in order to apply QoS between the different types of traffic. The first implemented scenario is shown in the figure below. When network topology and the routing protocol (OSPF) are already configured, students should go through the traffic configuration between nodes. First, they have to configure the applications used by the users, and then, the user profiles for these applications.

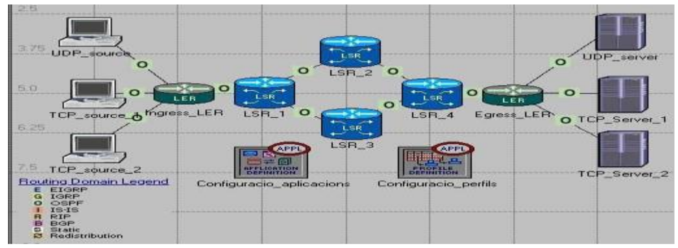


Figure.4. first implemented scenario using MPSL technology

Three data flows are generated. The first one goes from UDP_source to UDP_server, and it uses UDP in the transport layer. The other flows go from TCP_source1 and TCP_source2 to TCP_server1 and TCP_server2 respectively, with a constant TCP traffic of 1,5 Mbps. The following point-to-point link statistics are collected: throughput (bits/sec) and utilization in both directions.

Prediction and validation of networks:-

OPNET simulator is very useful when working with complex networks with a big number of devices and traffic flows, or in networks where a little change could be critical. Before implementing any change, it is possible to predict the behavior and to verify the configurations of the devices. OPNET has different tools that allow administrators to analyze their networks and the future implementations they want to do. Into this set of tools there are NetDoctor, ACE and MVI. In this part of the lab, students have to evaluate these tools using complex scenarios provided by OPNET. In the last scenario, QoS is added

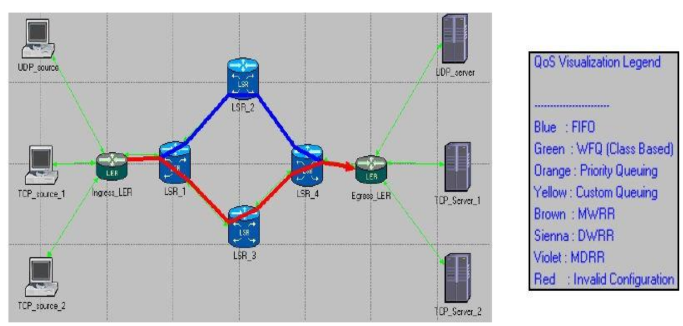


Figure .5. Last scenario, QoS is added.

When the QoS scheme is already defined, it is necessary to specify to which type of service each traffic belongs. The last step is to simulate the scenario and take conclusions about the graphics obtained.

Result Analysis:-

We present the simulation setup and performance evaluation results of our proposed start-network based intra-communi cation. This setup represents simulation results which are obtained from Opnet network simulator. Additionally, for the purpose of this paper, we are interested in how network adaptors and processor speeds affect gigabit throughput, how TCP/IP performs on Gigabit Ethernet networks, what is the impact in terms of delay and device drivers have on Gigabit Ethernet throughput, and what is the maximum attainable throughput and minimum latency that can be achieved for our system configuration. The throughput graph is plotted using throughput versus transfer block size. Throughput is reported in megabits per second (Mbps) and block size is reported in bytes since they are the common measurements used among vendors. The throughput graph clearly shows the throughput for each transfer block size and the maximum attainable throughput. The throughput graph combined with application specified requirements will help programmers to decide what block size to use for transmission in order to maximize the achievable bandwidth. Another important network performance measure is latency. In Opnet the latency is determined from the signature graph. This graph is plotted using throughput per second versus total transfer time elapsed in the test. The network latency coincides with the time of the first data point on the graph. In the remainder of this section, we present a detailed investigation of Gigabit Ethernet performance on the tested described earlier.

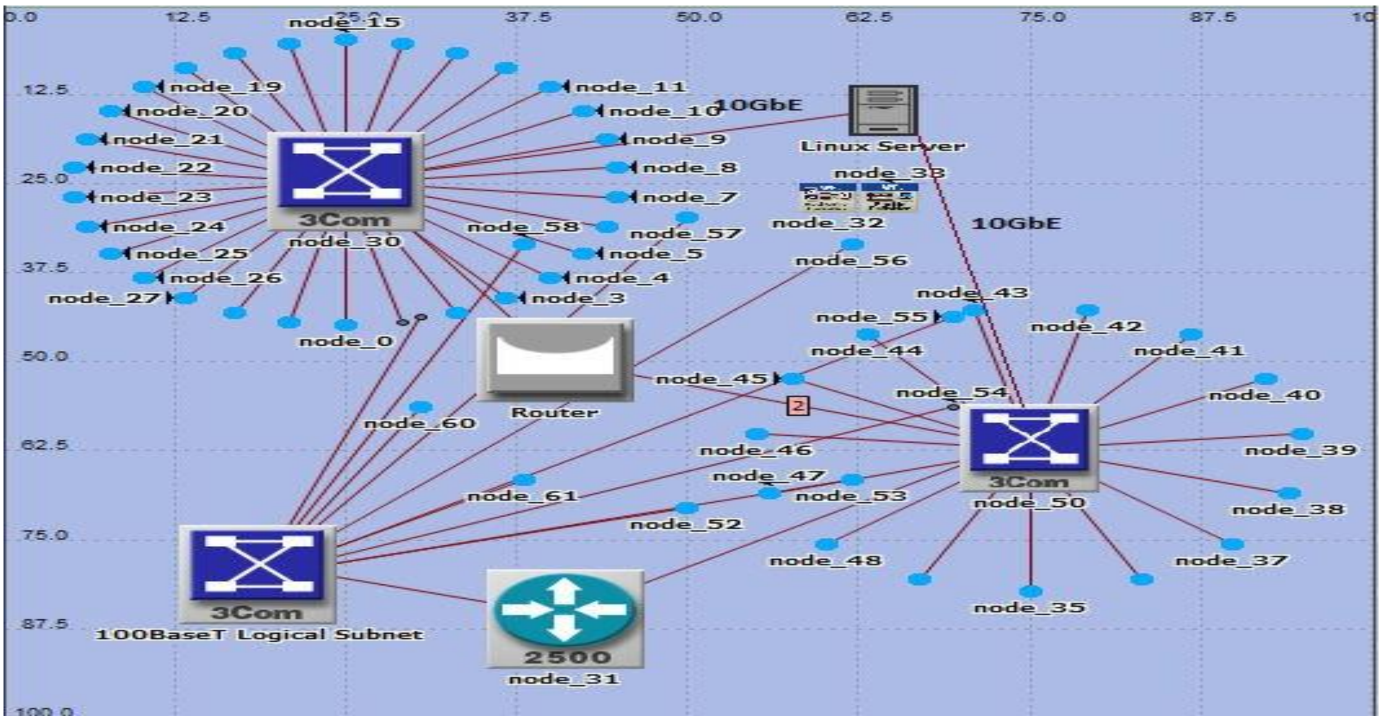


Figure.6. Simulation setup for high speed optical communication through 100BaseT Ethernet.

It provides accurate and useful information to reveal the network performance for each different block size. Opnet increases the transfer block size from a single byte to large blocks until transmission time exceeds 1 second. This allows examination of block sizes that are possibly slightly smaller or larger than an internal network buffer. Opnet clearly shows the overhead associated with different protocol layers, in particular TCP. Opnet was also slightly modified. This improved the robustness of the code with experimental drivers. Star-network based simulation is shown Figure 1 with high speed Ethernet (we use 100BaseT).

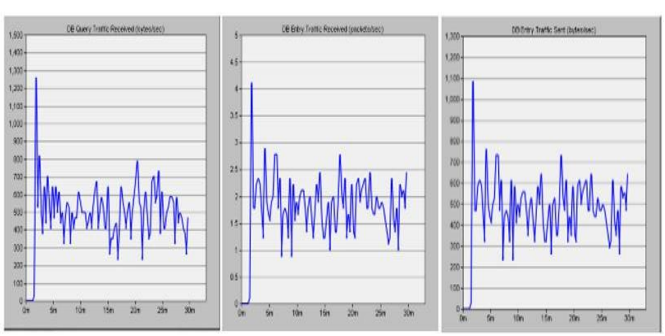


Figure .7. Globally1: Comparison (a) Ethernet delay and (b) RIP

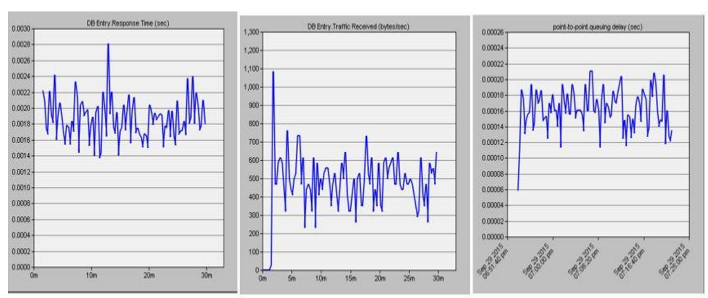


Figure .8. Globally2: Comparison (a) Ethernet delay and (b) RIP

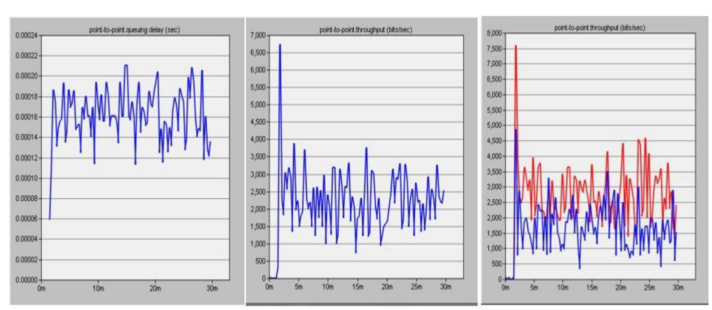


Figure .9. Globally3: Comparison (a) Ethernet delay and (b) RIP

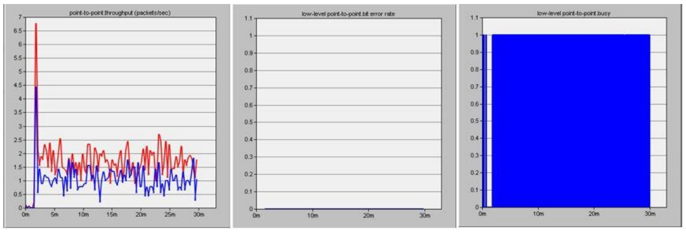


Figure.10. Globally4: Comparison (a) Ethernet delay and (b) RIP

II. CONCLUSION:

As organizations grow their networks and support bandwidth-intensive applications and traffic types, 10GbE technology is becoming ever more pervasive. 10GbE functionality can provide immediate performance benefits and safeguard a company's investment well into the future. Just as there are many manifestations of the gigabit and 10GbE standards to suit various networking environments, there are also many copper and fiber cabling technologies to support them. Companies must have a solid understanding of not only their environment and need, but also the different standards and cabling technologies available to them. Doing so will help them develop a sound migration and cabling strategy, enabling them to reap the benefits of 10GbE for years to come.

The major contributions of this work are:

1. Build a intra-network for optical communication
2. Collect statistics about network performance
3. Analyze these statistics
4. High-speed intra-network communications

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